Graph Traversal nal Linguistics III

Çağrı Çöltekin ccoltekin@sfs.uni-tuebingen.de

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· Depth first search follows the same idea as exploring a labyrinth with a string and a chalk

DFS - intuition

- Visit each intersection (node), while marking the path you took with the string
- Mark each visited node, backtrack (following the string) when hit a dead end

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Graph traversal * A graph traversal is a systematic way to visit all nodes in a graph

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DPS - intuition

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DFS - intuition

Graph traversal is one of the basic tasks on a graph, answering many interesting questions

Is there a path from one node to another?

What is the shortest path (with minimum number of edges) between the path connected?

Is the graph connected?

Is the graph cyclic?

Two main methods of traversals are breadth-first and depth-first

string

DFS - algorithm

· Depth-first search (DFS) is easy with def dfs(start, visited=Nome):
 if visited is Nome:
 visited = {start: Nome}
 for node in start.neighbors():
 if node not in visited:
 visited[node] = start

· DFS starts from a start node

· Marks each node it visits as visited (typically nut it in a set data structure)

. Then take an arbitrary sumisited neighbor and continue visiting the nodes reco

leads to the start node with no unvisited

· Algorithm terminates when backtracking nodes left

. The edges that we take to disc

tree are called forward edges

node are called the discovery edges

. The discovery edges form the DFS tree

. The other edges are called non-tree edges

. The edges to an ancestor in the DFS tree are

. The edges to a descendant node in the DFS

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DFS - demonstration, definitions

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Properties of DFS

· DFS visits all nodes in the concted comp

- Discovery edges form a spanning tree of the connected component
- If a node v is connected to the start node, there is a path from the start node v
 in the DFS tree
- . The DFS algorithm visits each node and checks each edge once (twice for
- undirected graphs
- \bullet The complexity of the algorithm is O(n+m) for n nodes and m edges

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BFS - intuition

· A way to think about breadth-first

- search (BFS) is to explore all options in parallel . In the maze, at every intersection
- send out people in all directions BFS divides the nodes into levels:
 - starting node at level 0
 nodes directly accessible
 at level 1



BFS - intuition

Dangers of DFS

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Part of

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BFS - algorithm

- def bfs(start) of bfs(start):
 queue = [start]
 visited = {start: None}
 while queue:
 current = queue.pop(0)
 for node in current.neighbors():
 if node not in visited:
 visited[node] = current · Typically BFS is implemented with a queue
 - The algorithm visits nodes closest to the start node firs
 - If you replace the queue with a stack, you get an iterative version of the DFS

BFS - demonstration



- · Similar to DPS, the edges that we take to discover a new node are called the discov edges
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BPS - demonstration

queue.append(node)



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Properties of BFS

- · DFS visits all nodes in the connected component from the start node Discovery edges form a spanning tree of the connected component
- . If a node v is reachable from the start node, the BFS finds the shortest path from the start node to v
- . The BFS algorithm visits each node and checks each edge once * The complexity of the algorithm is O(n + m) for n nodes and m edges

· Finding a path bet veen two n des (if one exi

- Testing whether G is connected
- Computing connected components of G

Problems solved by graph traversals

Detecting cycles

Finding a path between two nodes

- Traverse the graph from the source node, record the discovery edges · Start from the target node, trace the path back to the
- · With BFS, we get the
 - shortest path
- path = []
 if target in visited:
 path.append(target)
 current = target
 - while current is not source parent = visited[current]
- path.append(parent) current = parent urn path.reverse() * Running time is the length of the path: O(n)
- def find_path(source, target, visited):
 path =
- Find the connected components - Run traversal multiple times, until all nodes are visited · Is the graph cyclic?
- Is the graph connected?
 Yes if the "visited" nodes have the same length as the nodes of the graph. A directed graph is cyclic if there is a back edge during graph tra

Some other problems solved by graph traversal

- A undirected graph is cyclic if a traversal finds any visited nodes (if there are back, forward or cross edges)

Summary	Acknowledgments, credits, references
Traversal is one of the basic operations in graphs Graph traversals already solve some interesting problems: First a yeal to identify a solve the contraction of the problems: First cycles First cycles Reading on graphs: Coodrich, Tamassia, and Goldwasser (2013, chapter 14) Nest: More graph algorithms: special problems on directed graphs, shortest paths	☐ Goodrich, Michael T., Roberto Tamassia, and Michael H. Goldwasser (2013). Data Structures and Algorithms in Python. John Wiley & Sons, Incorporated. sase: 9781185(76734.
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